Notes on the Life History of *Nacaduba pactolus continentalis* Früh. (Lepidoptera : Lycaenidae) from Poona District, Western Ghats

BY

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(With two plates and four text-figures)

I am now able to contribute some observations on the early stages of this interesting jungle insect. As previously reported in this *Journal* (Vol. **56** : 647-52) it occurs in a small area of what I believe would be called climax jungle in the region of Khandala (Poona District, alt. *c.* 650 metres). This is its most northerly locality so far reported on the Western Ghats, and the only one I have managed to find. The food-plant occurs in isolated patches in the Khandala jungles.

The first undoubted egg was taken just after it had been laid on a young shoot of *Entada pursaetha* DC.[1] in the jungle on 23 October 1960. I managed to catch the butterfly immediately after I had seen it lay. On the same day I found four similar eggs on another *Entada* on which there were also about eight green Lycaenid larvae. On examining the spray on which the identified egg had been laid I found two egg-larvae.

Already in July 1960 I had tried to rear some similar larvae which died in their first or second moult.

The eggs found on 23 October 1960 did not hatch, but two of the green larvae found on the same day pupated on November 3 and 5. A small but otherwise perfect male *Nacaduba pactolus* emerged on 12 November 1960, and a deformed female on 13 November.

More eggs, and larvae at all stages, were found towards the end of the monsoon in September 1961. In spite of all care, and

[1] Santapau (1960) has established that this is the correct name of the *Entada* found at Khandala and along the Western Ghats generally. It had been known before this as *Entada scandens*.

invariably fresh, young foodstuff, only four larvae from twelve eggs attained even two-thirds of their growth.

However, on 1 October 1961 seven larvae mostly nearing full growth were found, two in association with *Camponotus* ants. Of these larvae one died in moult, and a presumably healthy specimen was put in preservative. The remaining larvae pupated, and produced five male *Nacaduba pactolus continentalis* on 10, 11, 12, and 16 October 1961, all perfect specimens.

I was away from India in 1962. In July 1963, after keeping a look-out from May, the butterfly was seen again and eggs were found. These did not hatch, but from early September until early November I had a number of successful rearings, four right through from the egg, and eight from first or second instar larvae. Details of the improved methods used will be given below. An equal number of males and females was obtained.

Description and Habits

Butterfly. The description in Wynter-Blyth (1957), based on Evans (1932), is reproduced for convenience: 'The 4-Lineblues UNF no pale basal lines; only a pair end cell, a discal pair and marginal markings. Tailed. UNF inner marginal line broad, diffused and continuous; all markings broad and yellowish. Wings broad and rounded, especially in the female. Male: above dark purple-brown, paler in a side light, with fine dark border line. Female: bases purple-blue, paling outwardly. Broad dark borders F; veins clearly marked.' Expanse: 34-38 mm. (Evans 1932).

Dr. T. Norman kindly sent me the following notes on the distribution and habits of the butterfly in Assam. He says: 'Over here it is a common and widely distributed insect in all types of forest, at least up to about 2000 ft. . . . Most of Cantlie's specimens came from medium altitudes, 3000 ft. to 4000 ft. on the southern side of the Khasi Hills. In Assam one finds it in ones and twos at damp sand beside streams or on forest paths (males only); or single specimens of both sexes flying in the undergrowth. It does not fly outside the forest, nor does it ever join the big "congregations" of *Nacaduba* spp. at damp patches. . . . When I say it is suite common, I mean that on a day's outing at the right season, and providing one was concentrating on this species only, one would be able to take perhaps 50 specimens.'

Judging by the number of examples seen or caught, and the many eggs and larvae noticed, the species appeared to be common in the

Khandala jungle during the monsoon of 1963. It does not seem to mind rain, and flies during drizzle. When a heavy shower comes it takes shelter. I caught one in such circumstances clinging to a bare stalk, body up, wings down. As soon as there is some lightening of the sky and slight warmth from the sun behind the driven clouds it is again on the wing. I saw the males perching high on the *Entada*, about thirty feet up, and coming down to lower leaves in a clearing when light rain had passed. Unfortunately I failed to capture one.

I found that the butterfly is quite eager for the nectar of flowers. This is not surprising when one considers it must need to have its energies renewed after long periods of cold and damp. I caught two females and one male at flowers of a *Justicia*, probably *diffusa*, (Acanthaceae), which at the latter end of the rains grows all over the open patches outside the thick jungle.

Egg. I found the egg on the young leaves, shoots, and tendrils of *Entada pursaetha*. Both young plants and the new growths of ancient lianas seem equally suitable. The eggs were found on the undersurfaces of young red leaflets or perhaps more often in their axils. Leaves which have turned green will do, but they must be very tender. A favourite place is the terminal bud of a new shoot which will open out into ideal food three days later at the same time as the larva hatches.

The general colour of a *pactolus* egg is honey-yellow to the naked eye, but for some reason it seems whiter under the microscope. The white cell walls no doubt contribute to this effect.

The height is about one-third of the breadth. In shape it is a very flat egg, reminiscent of a Government servant's *pagri*.

Looked at from above there seem to be about four rows of cells decreasing in size between the edge of the top surface and the central space around the micropyle. The cells have irregular white walls enclosing rough hexagons in some cases, but more often squarish shapes, the floor of these cells is minutely pitted irregularly all over. The top surface of the egg is depressed, and the central space containing the micropyle is dark grey, minutely tubercular, and rather bigger than the large white-walled cells on the outside edge of the egg. A lighter grey extends outside the dark grey central space, and gives the effect of a roughly drawn four-pointed star.

Viewed from the side the flatness of the egg and the irregularity of the cells is apparent. Both on the top surface and on the sides the cells consist of lumps joined together by wide walls. The larger lumps, at least, have a low depression in their crown.

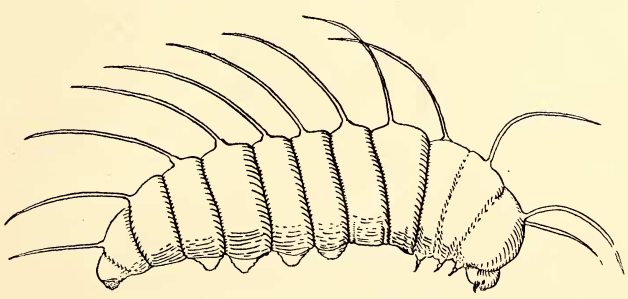
It should be mentioned that, in contrast with *pactolus*, the egg of

Nacaduba beroe gythion Früh. is rounder in contour. The cells consist of a larger number of small rounded knobs, more than the lumps in *pactolus*; the knobs are connected by narrow walls, giving a prickly contour and in general reminding one of a golf ball. Bell (1918)[1] aptly describes the rows of knobs on a *beroe* egg as radiating 'outwards in slowly diverging curves like a catherine wheel firework'. This is quite unlike the slabby appearance of *pactolus*.

In the jungle in question *N. beroe* as well as *N. pactolus* lay on *Entada*, so it is useful to be able to distinguish the two eggs with fair certainty in the field. In *pactolus* there is always a grey centre and it may look yellow; *beroe* has no darkened centre and always looks enamel-white, although the ground colour is actually yellow.

The eggs of *N. pactolus* do not seem to change noticeably in colour before the little larva comes out. This may indicate either that the eggshell is thick, or that the lumpy cell-walls hide any change of colour from casual observation. On the two occasions when I did notice a change to dark blue or violet the larvae did not emerge.

Larva. The young larvae vary in colour from pale yellow to honey-yellow. In the first instar they have the usual row of long dorsal bristles, and shorter lateral hairs. The dorsal bristles, particularly, must act as a spring when the little larva falls, and protect it generally. They were brown in a day-old larva. The lateral hairs were lighter in colour, and so far as I could see alternately long and short. None were as long as the dorsal bristles. See Text-fig. 1,



Text-fig. 1. Egg-larva (diagrammatic)

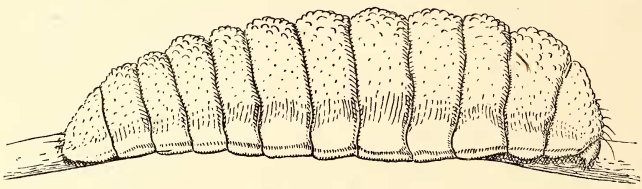
where for lack of sufficient information the lateral hairs are not shown.

[1] For an unrivalled description of *Nacaduba beroe* at all stages, see Bell (1918, pp. 661-4) under the name *Nacaduba plumbeomicans* W.-M. & De N.

At the first moult the hairs are shed with the skin, and the colour becomes apple-green, sometimes with a red-brown line above the legs fading out at about somite 3. The fore-end is now massive and the general shape rather carrot-like, especially in the resting position when the head is drawn into the thorax. The small head is pale yellow, with eyes and mouth-parts dark brown. It is usually more or less hidden by the first thoracic segment, but darts forward quite often when the creature is eating. There may be a light-brown suffusion on the first few segments, and usually a dark-green rather vague dorsal line, most noticeable from the third thoracic to the third abdominal segment. Palpitation of the aorta can be seen along this line. There is also some darker green dorsally on segments 7 and 8 of the abdomen. It is on these segments that the median-dorsal secretory organ and the dorso-lateral eversible organs are situated.

When once the larva had shed its long-haired vestiture and become green I observed no colour changes throughout the remaining stages. There may well be a pink form as in *N. beroe* but I have not come across it.

The whole skin surface of the larva is minutely pitted, most noticeably in the full-grown larva (Text-fig. 2). The ample folds and creases of the forepart of the thorax then make it quite impressively elephantine under the lens. At maximum growth it is about 12 mm. long.



Text-fig. 2. Full-grown larva (diagrammatic)

Larval habits. Eclosion took place in the usual three days after the egg was laid. The little larva did not consume the eggshell, at least in captivity. It gets out more or less from the side of the egg. A larva, shortly after emerging, was seen to go to the underside of a small green leaflet, where it began to eat irregular holes, leaving the upper epidermis as a transparent film. The young larvae are fairly active and may move from one leaflet to another, eating here and there, and this in spite of the food being quite fresh. They keep to the undersides of the leaflets. They do not get between the young

red leaflets while they are still pressed together before expansion. In contrast, young *N. beroe* larvae make a practice of getting into such places and feeding there.

As with many Lycaenid larvae, it is difficult to tell whether *pactolus* are about to moult or are simply resting between meals. The moult is, of course, a crucial time with all caterpillars, and in this case I had continual disappointments when I tried to bring them through in closed glass jars. I used this method in order to keep the delicate food fresh; I changed the jars daily, disinfecting and drying them, and provided new food daily from plants grown at home. In spite of all this I lost most of my larvae in their first moult after they were collected. In this air-tight method, which is so often successful in other cases, *Entada* may not keep as fresh as it seems, and this may have an effect on skin-changing. Even more likely, the constricted places into which the larvae get for their moult may be too damp for them at these times.

Whatever the reason, it was plain that an airy atmosphere, at the same time much damper than that of Poona, would have to be provided. So in 1963 I put larvae on the growing plant on the veranda in Poona confining them with cellophane sleeves. Air was brought in through a small panel of fine gauze, fixed with cellotape. The sleeves were open at both ends. First they were slipped over a suitable spray of young leaves and shoots. Then they were tied as tightly as possible at the bottom with strong thread. The larvae were dropped in through the top opening, which was folded over and shut with bulldog clips or paper clips. The contraption was then held upright by a string fixed to a support.

Apparently the cellophane sleeves gave approximately the atmosphere of the forest in the monsoon; 'sweat' and mould were avoided, and there were few deaths from any cause. When a larva was to be examined it could usually be located by opening the top of the sleeve. When it was ready to pupate it nearly always went down to the bottom end of the sleeve, but could usually be slid out of the top end into a dish, a safer way than opening the bottom end. As they are bad cannibals from the start, in captivity at least, they were sleeved separately.

Throughout their life these larvae are capable of dropping by a thread, but even when young they do not do so readily. On one occasion a leaflet I was cutting off with a larva on it fell to the jungle floor, and when I was lucky enough to spot the cutting the larva was still in position.

The larvae are well protected by resemblance to various parts of their food-plant. They are not conspicuous, even when green, on the yellowish tendrils—in the green stages they look astonishingly like leafbuds and stipules. When there are red lines above the legs these blend perfectly with the red borders of the young green leaflets.

The larvae will eat only tender leaves, whether red or green; green leaves which have grown a hard skin will not do. They like the terminal buds and the newly expanded leaves, also the yellowish shoots and tendrils. They live under the leaves a great deal. After the first moult or two they eat irregular holes right through from the mid-vein outwards. As *Entada* does not shoot again in the same place for a considerable time, it is a good thing to avoid cutting off the whole of a leading shoot in the excitement of collecting the larvae. Even in September and October there may not be many young growths, and several larvae were often found crowded together on one or two shoots.

Growth is rapid, as it must be with a larva which eats only the young leaves of a plant which does not produce them frequently. Notes from my 1963 records show this:

Eggs laid probably on 26 or 27 September were collected on 29th and produced larvae on 30th. These moulted about 2 October and had grown to 1.5 mm. in length. On 10 and 11 October larvae were found full grown in the sleeve. They pupated on 13th and three butterflies emerged on 21st, making 24 or 25 days from egg to imago.

As it is not possible to observe larvae in a sleeve closely, the following notes on the stages of growth are incomplete, but are nevertheless of interest as records of my first *pactolus* brought through from collected eggs:

8-9-1963	Eggs collected	In air-tight container
9-9-1963	Larvae emerged	
11-9-1963	First moult. Length 1.5 mm.	Transferred to cellophane sleeve
18-9-1963	Length 10 mm.	
19-9-1963	Length 11 mm.	
20-9-1963	Spun pad for pupation on the side of a zinc container, just above the earth	
23-9-1963	Pupation	
30-9-1963	Female emerged at 13.30 hours.	

The above seems to show that a moult occurs about every two days. As observed, the metamorphosis is usually accomplished in the short period of about 25 days.

Attendance by ants. I did not come across many ants on the *Entada* plants, and none attending anything, until on 1 October 1961 I found a *Camponotus* looking after a membracid. Shortly afterwards

I found two more *Camponotus* each actually attending a *pactolus* larva. One was stationed just behind its larva in the typical 'attending' posture, with waving antennae and a generally possessive air. It was a small black *Camponotus*, and when first seen with the larva had its abdomen tucked under the thorax. The other ant was sitting in a clump of leaflets which looked as if they had been drawn together by a spider, and from this hide it was keeping a close watch on a larva. It was a light brown ant, and moved deliberately except when alarmed, when it tried to elude me by a series of jerky spurts.

Later I saw the light-brown ant paying some attention to one of the larvae in captivity, without apparently getting any response. Apart from this the ants and the larvae seemed indifferent to one another. Presumably, therefore, *pactolus* is not dependent on ants. If it was, I should have expected the *Camponotus* to behave as I have seen them do, under similar conditions of captivity, with larvae of the genus *Tarucus*—*Camponotus* attended these continuously, without a thought for anything else, thriving on nourishment from the larvae right up to pupation. In such cases ants lose their normal desire to hurry back to the nest, and may be said to be demoralized. But with *pactolus* the two *Camponotus* were restless, and died in three days.

The ant relationship therefore appears to be intermittent, and probably is not essential for the health of the larva. However, the presence even of ants distracted by captivity may be good for the larvae. Certainly, five out of the six larvae found on 1-10-1961 did produce butterflies after having been kept with ants found with two of them. On the other hand, success may have been due entirely to the fact that these larvae had got safely through their moults.

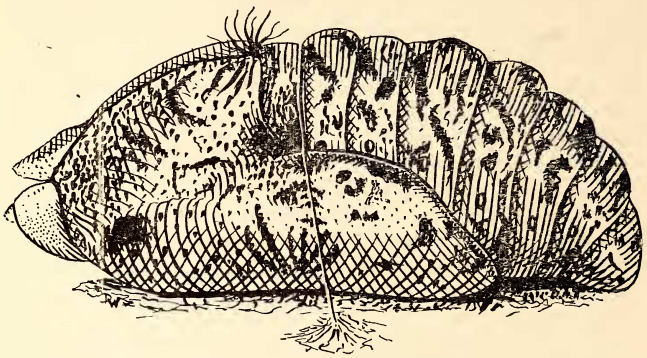
It is likely that other ants look after *pactolus* larvae; at various times I tried *Prenolepis* and a small yellow ant, probably a Cremastogaster, from about the house, and once saw response to the latter. The larva put out the organs of segment 8 and the ant rode on its back for a short time. I have caused the organs to evert by tickling with a small paint-brush.

No ant relationship is to be expected before the larvae reach the 'green stage'. Until then they are protected against dangers by the long bristles, and presumably have not developed their ant-glands.

Parasites. No larvae or pupae under observation seemed to have been parasitized by Hymenoptera or Diptera. If they were, the facts may become known when the larvae which died are dissected.

One nearly full-grown larva died after two very long worms had left its body. They are probably *Gordius*, as they got into a great tangle. They have been preserved with their host.

Pupa. This is of the normal Lycaenid shape, 'like a trussed chicken', and very like the other *Nacaduba* pupae I have seen (Text-fig. 3). My specimens were reddish brown in colour with dark spots and blotches. The drawing was done from a pupa skin, not unfortunately from the living pupa. The five 1961 pupae were all about the same size: length 10.5 mm., breadth at thorax 3 mm., and across the third somite of the abdomen and the wing cases about 4 mm.



Text-fig. 3. Pupa skin (diagrammatic)

A newly formed pupa had a pink abdomen, green wing-cases, and brown upper thorax. The dark blotches were visible but not prominent. The next day the wing-cases were yellow-ochre, and the abdomen still pinkish but inclining to brown.

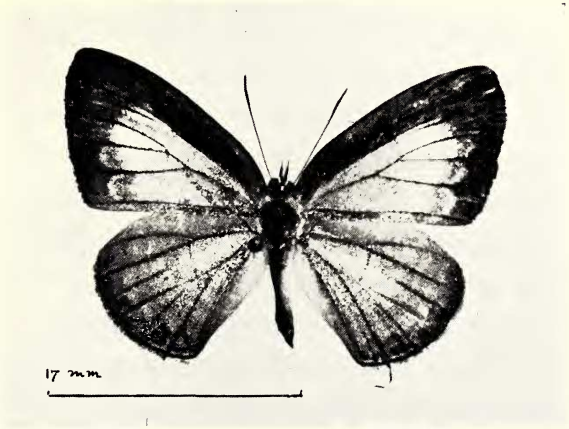
Judging by the nineteen *pactolus* pupae I have seen, there is no marked difference between them and those of *N. beroe*, of which I have seen numbers and have specimens and skins for comparison. The former are slightly larger, and more robust in appearance; the ground colour is redder and the spots larger and darker.

Before their change the five 1961 larvae took up the following positions: (1) on lower surface of a leaflet; (2) and (3) almost touching one another and in between two leaflets, near the petioles, and concealed from view—the leaflets were drawn together with bits of silk in an inefficient-looking manner; (4) on the upper surface of the same leaflet as No. 1; (5) on the bottom of a glass jar.

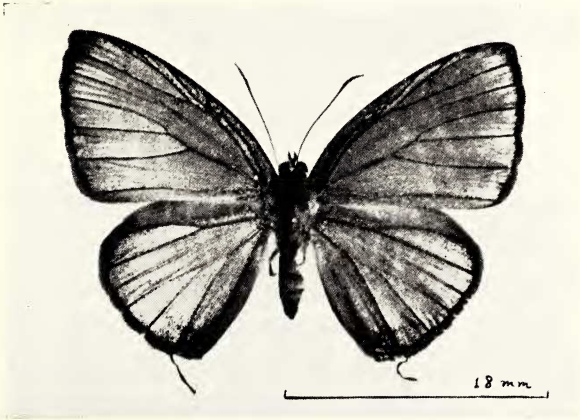
After spinning its pad and girdle a larva was 11 mm. long, purplish brown above and towards the front end, pinkish in the rear.

In 1963 the larvae were taken out of the sleeve when ready to pupate and placed in plastic cages with damp earth and dead leaves.

Nacaduba pactolus continentalis Früh.



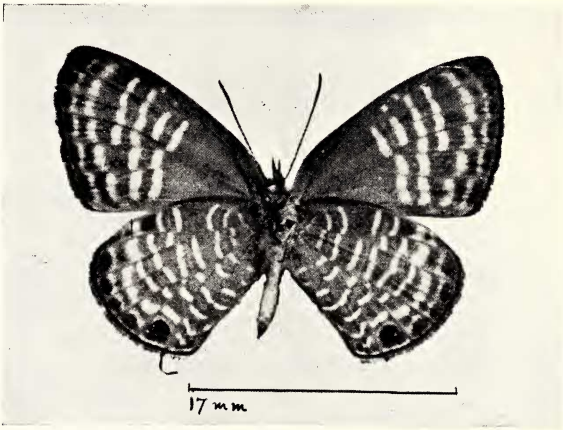
Female : Upper side
(Caught specimen : 23–10–1960)



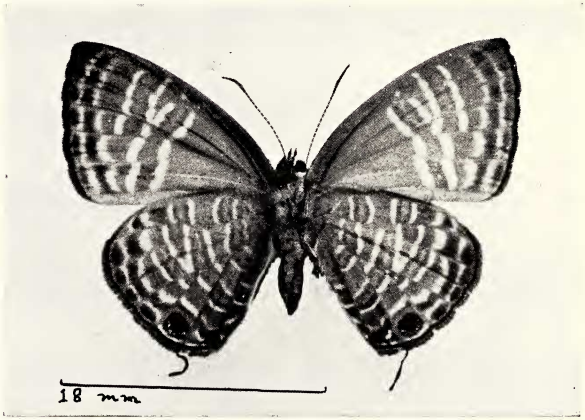
Male : Upper side
(From larva : 11–10–1960)

(*Photos : A. E. Bean*)

Nacaduba pactolus continentalis Früh.



Female : Under side
(Caught specimen : 23–10–1960)



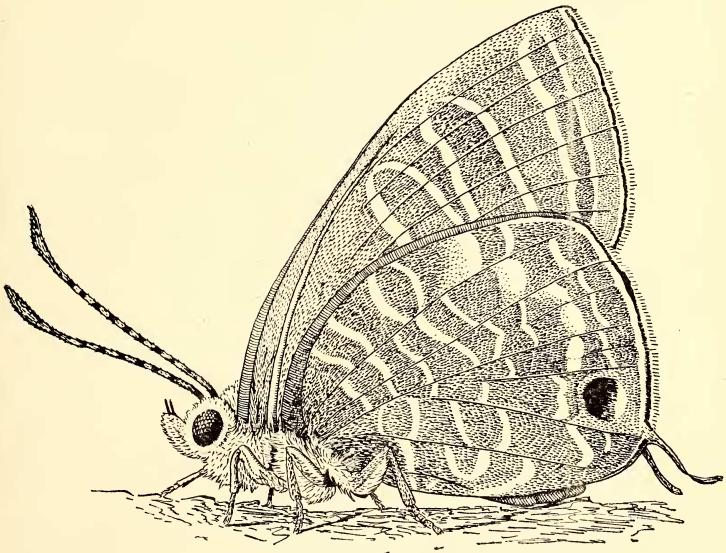
Male : Under side
(From larva : 11–10–1961)

(*Photos : A. E. Bean*)

Some spun up in the leaves, either merely in between them, or in a cocoon formed by drawing them together with silk. One formed its pupa, as noted above, on the side of the zinc bottom of the cage, just above the surface of the earth, and another right up under the lid.

Both in 1961 and in 1963 the pupa cages were kept in a conditioned atmosphere. This was simply a wooden box covered with a sheet of glass, containing a large zinc lid kept full of water. As a precaution against mould the water was treated with a tiny quantity of formaldehyde 40%, usually added when the water was renewed. The plastic cages themselves were sufficiently aerated, and the glass cover of the wooden box was not tight fitting. When the butterflies were due I was usually there to give them plenty of air for expanding their wings, but they did perfectly well without this attention. (See Oldroyd p. 70.)

Emergence of the Butterfly (Text-fig. 4 and Plates I-II). In 1961 the butterflies, all males, emerged in seven or eight days, all but one



Text-fig. 4. Male, with newly expanded wings

at about 4 p.m., and not at 9 or 10 in the morning as I had expected.

The two emergences in 1960 occurred at about 10 a.m. in sunny weather, but in 1961 the weather was damp and dull.

Before the butterfly comes out the pupa becomes much darker, which is of course the general rule. But in the case of *pactolus* the darkening occurs, apparently, the day before, and on the day of emergence the dark retreats to certain areas and the general colour gets much lighter again. It may be that this happens in other butterflies, but I had not been keen enough to notice such things until I had *pactolus*. In 1960, with only two pupae, I looked at them frequently, and on about the eighth day saw that one had turned very dark. Every time I had another look at it I expected to see the butterfly. By the end of the day I had given up hope. But in the morning the dark colour was redistributed, and to my surprise and delight a male butterfly came out.

In 1961 there were the same changes in colour, and as the butterflies came out later in the day it was more convenient for me. I made the following notes:

11-10-1961 :

09.15 hrs. Pupa No. 4 is shining brownish black, the spiracles whitish brown.

12.15 hrs. A whitish patch has appeared on either side of the head. The wing-cases are more strongly demarcated because of an indentation which has appeared along their dorsal margin. The black ground colour shows up some short white hairs on the abdominal segments not noticed before.

13.15 hrs. The black has now retreated to a diffused dorsal line, leaving the rest of the surface brown, faintly marbled with darker, especially on the wing-cases. A lighter patch has appeared on segment 5 of the abdomen. The palpi now show as near-white streaks just below the eyes. The girdle seems tighter and more obvious.

14.00 hrs. A mite twice explored the pupa, especially around the head and wing-cases, but to my relief went off each time into some dead leaves.

I was fortunate in witnessing the butterfly actually come out of pupa No. 4. It happened very quickly at about 4 p.m. The wings expanded within five minutes, but for the first quarter of an hour some of the forewing remained hidden by the hindwing. After this the wings were held in the normal resting position of the genus, with most of the forewing showing.

These males soon became too restless for me to sketch them, but I got the pose of the example illustrated while the forewings were still drawn below the hindwings. The fresh specimens were a pretty sight; in one case I noticed some of the powdery stuff from